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Multiple-criteria Evaluation of Quality of Human Capital in the European Union Countries

Abstract

Successful policies and programs leading to improvement of quality of human capital in the context of knowledge-based economy are currently considered as the basic condition for keeping global competitiveness of the European economy. It has been pointed as one of the most important aims of Europe 2020 strategy. In the EU all the countries are obliged to implement national strategies that should result in reaching that aims. As a result, it is necessary to compare countries' results, which can be useful for pointing the best practices and effective policy guidelines. Thus, the main aim of the article is to provide a multiple-criteria analysis of the quality of human capital in the EU countries at macroeconomic level. Special attention is given here to the results obtained by new member states of the EU. The research is done for the years 2001-2012. Additionally, it gives some insight on the possible influence of the global financial crisis on the dynamics of the quality of human capital in the EU countries. Data from Eurostat is used. Hellwig's method of taxonomic measure of development with the constant pattern (ideal solution) for the entire period is applied in the research. The Hellwig's method is very close to TOPSIS method, which is based on a concept of similarity to ideal solution and which is currently commonly applied in multiple-criteria decision-making (MCDM). After obtaining the relative measure for the quality of human capital, the countries were grouped into homogenous subsets with application of natural breaks method. The main advantages of the applied methods are high elasticity and methodological simplicity, which is crucial in the case of multiple-criteria decision analysis (MCDA).

JEL Classification: *C38, E24*

Keywords: *multiple-criteria decision-making (MCDM), multiple-criteria decision analysis (MCDA), Hellwig's method, human capital, European Union*

Introduction

Quality of human capital (QHC), both at microeconomic and macroeconomic level, is currently considered as the main growth factor in developed economics. The process of creation of high value added in the reality of global competitive knowledge-based economy is not possible without constant effort to improve the QHC. Thus, from the long term perspective effective policies supporting multifactor development of the QHC in the context of knowledge-based economy make the condition for keeping global competitiveness of every developed economy. In the European economy it has been stated as one of the most important aims of the Europe 2020 strategy (Balcerzak, 2015, pp. 190-2010; European Commission, 2010; Hobza & Mourre, 2010). However, the economic role of the QHC is not only crucial form the perspective of long term macroeconomic development. For example in the short term it influences the situation on the labour markets (Müller-Frączek & Pietrzak, 2011, pp. 205-209; Pietrzak & Balcerzak, 2016a; Balcerzak (ed.), 2009; Balcerzak & Żurek, 2011, 3-14), the economic and social cohesion

of regions and cities (Wilk *et al.*, 2013, pp. 124-132; Pietrzak *et al.*, 2014, pp. 135-144) or countries fiscal sustainability (Balcerzak *et al*., 2016, pp. 483-496; Balcerzak and Rogalska, 2016, pp. 271-282). Thus, the research on the QHC is important both form long and short term perspective.

In the EU all governments implement national strategies that should support improvement of the QHS. In this context, it is necessary to compare countries' results, which can be useful for pointing the best practices and effective policy guidelines in the field. Thus, the main objective of the article is to provide a multiple-criteria analysis of the QHC in the EU countries at macroeconomic level. In the research the special attention is given to the results obtained by new member states of the EU. The research was based on the Eurostat data for the years 2001-2012. Furthermore, the analysis was done for two sub-periods 2001-2007 and 2007-2012. This approach enables to provide some insight on the probable influence of the global financial crisis on the changes of the QHC in the European economy.

Additional operational aim of the paper is to provide input data on the QHC that can be used in econometric modeling of macroeconomic determinants of development and growth of European economies (see Pietrzak & Balcerzak, 2016b; Balcerzak & Pietrzak 2016a; 2016b; Balcerzak & Pietrzak, 2015, pp. 93-106; Balcerzak, 2009, pp. 711-739). The article is a continuation of previous research of the author in the field (Balcerzak & Pietrzak, 2016c; Balcerzak, 2011, pp. 456-467).

Data and Selection of Diagnostic Variables

The QHC analyzed form macroeconomic perspective must be treated as complex multivariate phenomenon. It should be quantified with application of taxonomy tools and multiple-criteria decision analysis (MCDA) methodological approach (see: Balcerzak & Pietrzak, 2016d; Kunasz, 2009, pp. 35-48; Pawlas, 2009, pp. 21-31; Pietrzak & Balcerzak, 2016c; Wronowska, 2009, pp. 32-45; David, & Goddard Lopez, 2001).

In the case of every multiple-criteria analysis the most significant problem is the choice of diagnostic variables that are used in the quantification of a given phenomenon. It must be stressed that the final results are always strongly influenced by the choice of the diagnostic variables (Gostkowski, 1972, pp. 15-17). This is especially important in the case of difficult to measure and quite often qualitative factor such as the QHC. As a results, in the first stage based on the review of literature related to previous research on the QHC a set of preliminary variables was selected, which in the second stage were verified with the application of formal taxonomic criteria of information value (Zeliaś (Ed.), 2000, pp. 127-133).

In regard to the first stage, based on the theoretical models mostly proposed by the economists working on endogenous growth (Cichy, 2009; Cichy & Malaga, 2006, pp. 5-24; Florczak, 2007, pp. 112-167), empirical research (Wronowska, 2015, pp. 33-45; Okoń-Horodyńska & Wisła (Eds.), 2010; Herbst (Ed)., 2007; Laroche *et al*., 1999, pp. 87-100) and the data proposed by Eurostat 26 factors presented in table 1 were chosen for a sets of preliminary diagnostic variables. As the EU economies must compete in the reality of global knowledge-based economy (Madrak-Grochowska, 2015, pp. 7-21; Libertowska, 2014, pp. 93-107; Stankiewicz & Moczulska, 2015, pp. 37-51; Ciborowski, 2014, pp. 57-72; Sachpazidu-Wójcicka, 2014, pp. 93-107) at this stage the choice of potential diagnostic variables was strongly influenced by the macroeconomic and structural requirements created by this phenomenon. The variables were classified as stimulants and dis-stimulants, where the first once are treated as the factors that improve the QHC and the second once describe the aspects that hamper it.

Table 1. Set of potential diagnostic variables used in the research

x_{jt}	Potential diagnostic variable	Classification of the variable
x_{1t}	Effectiveness of lobur force – product per hour worked	Stimulant
x_{2t}	Effectiveness of lobur force – product per person employed	Stimulant
x_{3t}	Employment rate among people in the age 20 to 64 years (% of population)	Stimulant
x_{4t}	Employment rate among people in the age 55 to 64 years (% of population)	Stimulant
x_{5t}	Unemployment rate (annual average %)	dis-stimulants
x_{6t}	Long-term unemployment - % of active population	dis-stimulants
x_{7t}	Average age of leaving labor force	Stimulant
x_{8t}	Low educational attainment - % of population with less than primary, primary and lower secondary education in the age 18 to 24.	dis-stimulants
x_{9t}	Educational attainment - % of population in the age 25 to 34 with tertiary education	Stimulant
x_{10t}	Participation rate in education and training for population in the age from 25 to 64 years	Stimulant
x_{11t}	Government investment in human capital - expenditure on education as % of GDP	Stimulant
x_{12t}	Total intramural R&D expenditure (GERD) percentage of gross domestic product (GDP)	Stimulant
x_{13t}	Human resources in science and technology as a share of total labour force	Stimulant
x_{14t}	Patent applications to the European Patent Office - number of applications per million inhabitants	Stimulant
x_{15t}	Patents granted by the United States Patent and Trademark Office - number of patents per million inhabitants	Stimulant
x_{16t}	Tertiary graduates in science and technology per 1 000 inhabitants aged 20-29 years	Stimulant
x_{17t}	Individuals' level of Internet skills - individuals who have carried out the Internet related activities - percentage of the total number of individuals aged 16 to 74	Stimulant
x_{18t}	Individuals´ level of computer skills - individuals who have carried out the computer related activities - percentage of the total number of individuals aged 16 to 74	Stimulant
x_{19t}	E-Commerce via Internet - percentage of enterprises' total turnover from E-commerce via Internet	Stimulant
x_{20t}	E-government usage by individuals by gender - percentage of individuals aged 16 to 74 using the Internet for interaction with public authorities	Stimulant
x_{21t}	ICT expenditure - percentage of GDP	Stimulant
x_{22t}	High-tech exports - exports of high technology products as a share of total exports	Stimulant
x_{23t}	Life expectancy at birth	Stimulant
x_{24t}	Healthy life years expectancy at birth	Stimulant
x_{25t}	Severe material deprivation - % of population	dis-stimulants
x_{26t}	Population at-risk-of-poverty - % of population	dis-stimulants

Source: own work.

In regard to the second stage, after the analysis of completeness of the data for the whole analytical period, all the variables were evaluated from the perspective of their information value. It is assumed that in the case of multiple-criteria analysis the diagnostic

variables should be characterized with three formal statistical criteria: a) high level of variation, b) high information value, c) low level of correlation (Zeliaś (Ed.), pp. 127-133; Hellwig, 1972a, pp. 69-90).

First of all, the variables used in the taxonomic research should not be similar to each other in the sense of information concerning the objects. In order to evaluate that factor the coefficient of variation is commonly used, where the variables that do not fulfill arbitrary given criterion for example such as $\varepsilon < 0{,}1$ are eliminated from the research.

Then, the variables characterized with high information value usually reach high values with relatively great difficulty. In order to evaluate the information values of the variable the skewness coefficient can be used. It is assumed that in the case of stimulants for the important factors the distribution of the variable should be right-skewed. When in the case of stimulants the distribution is left-skewed, it means that most of the objects easily reach high values of the measure for a given factor. Thus, the variable does not differentiate the objects significantly and it should be removed from the research.

In the end, the variables should not be highly correlated, as high correlation of the diagnostic variables could result in the overlapping of information on the analyzed objects. In the case of high correlation of the variables a parametric method proposed by Hellwig can be applied, where the maximum value of correlation coefficient for the variables can be set as $r = 0{,}8$.

In the case of studies conducted for longer periods the sets of variables that fulfill all the three formal criteria are usually different in the analyzed years. As a result, the final decision on acceptance of a given variable to the final set of diagnostic variables can be based on the frequency of repetition of a given variable in the sets of accepted and rejected variables in the analyzed years (Zeliaś (Ed.), 2000, pp. 127-133). Based on the described procedure it was necessary to reduce the set of potential variables to six variables that are given in the table 2. All the final diagnostic variables were classified as stimulants.

Table 2. Set of final diagnostic variables that fulfilled all the criteria of information value

x_{jt}	**Final diagnostic variables**	**Classification of the variable**
x_{1t}	Effectiveness of lobur force – product per hour worked	Stimulant
x_{4t}	Employment rate among people in the age 55 to 64 years (% of population)	Stimulant
X_{9t}	Educational attainment - % of population in the age 25 to 34 with tertiary education	Stimulant
x_{10t}	Participation rate in education and training population in the age from 25 to 64 years	Stimulant
x_{12t}	Total intramural R&D expenditure (GERD) percentage of gross domestic product (GDP)	Stimulant
x_{16t}	Tertiary graduates in science and technology per 1 000 inhabitants aged 20-29 years	Stimulant

Source: own work.

In order to unify the diagnostic variables and make them comparable, the variables were standardized with application of classic standardization procedure given with equation 1. This procedure enables to obtain the variables characterized with mean at the level 0 and variance that is equal to 1.

$$x_{ijt} := \frac{x_{ijt} - \overline{x_{jt}}}{s_{jt}} \qquad i = 1,2,..n,\ j = 1,2,...,p,\ t = 1,2,..l \qquad (1)$$

where $\overline{x_{jt}}$ and s_{jt} are given with formulas 2.

$$\overline{x_{jt}} = \frac{1}{n}\sum_{i=1}^{n} x_{ijt} \;,\; s_{jt} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_{ijt} - \overline{x_{ijt}})^2} \quad i = 1,2,..n,\, j = 1,2,...,p,\, t = 1,2,..l \quad (2)$$

Hellwig's Method of the Multiple-criteria Decision Analysis

In current literature one can find a great variety of methods for multiple-criteria decision analysis and taxonomic research (Mardani *et al*., 2016, pp. 1-16; Mardani *et al*., 2015, pp. 4126-4148; Zavadskas *et al*., 2014, pp. 165-179; Balcerzak & Pietrzak, 2016e; Pietrzak & Balcerzak, 2016d; Jantoń-Drozdowska & Majewska, 2015, pp. 61-83; Jurkowska, 2014, pp. 49-73; Mościbrodzka, 2014, pp. 29-47). In the case of current research Hellwig's method of taxonomic measure of development with constant pattern (ideal solution) for the entire period was used. The application of constant pattern was the condition for dynamic comparison of the research results. Additionally, it enabled to obtain time series that can be used as an input data for future econometric research, which was stated as the additional operational aim of the paper.

The proposed method is very close to Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), which is based on a concept of similarity to ideal solution, and which is currently commonly applied in multiple-criteria decision-making (MCDM) (Hwang & Yoon, 1981; Yoon & Hwang, 1995). However, Hellwig's method was developed a few decades before TOPSIS. It was originally proposed in 1968 as a taxonomic method for international comparisons of economic development of countries (Hellwig, 1968, pp. 323-326). It was disseminated in the international literature in 1972 with realization of UNESCO research project on the human resources indicators for less developed countries (Hellwig, 1972b, 115-134). The main advantages of the method are high elasticity and methodological simplicity, which is crucial in the case of multiple-criteria decision analysis.

The core of the Hellwig's concept is a construction of synthetic variable (the taxonomic measure of economic development – TMD) that is designed as a distance from the abstract pattern of economic development (ideal solution). In this approach it is determined with formulas 1 and 2.

$$x_{0\,jt} = \max_{it} x_{ijt} \quad \text{for} \quad j \in S, \;\; i = 1, 2,..., n;\;\; j = 1, 2,..., p;\;\; t = 1, 2,..., l, \quad (1)$$

$$x_{0\,jt} = \min_{it} x_{ijt} \quad \text{for} \quad j \in D, \;\; i = 1, 2,..., n;\;\; j = 1, 2,..., p;\;\; t = 1, 2,..., l, \quad (2)$$

where S relates to a set of standardized stimulants and D relates to a set of standardized dis-stimulants.

The main difference between the Hellwig's method and the TOPSIS relates to the construction of the pattern of economic development (ideal solution). In the case of TOPSIS method not only positive ideal solution but also negative ideal solution is taken into consideration.

The distance from the pattern of economic development is estimated with the equation 3.

$$d_{i0t} = \sqrt{\sum_{j=1}^{p} (x_{ijt} - x_{0jt})^2} \qquad i = 1, 2, ..., n;\ j = 1, 2, ..., p;\ t = 1, 2, ..., l. \tag{3}$$

TMD is given with formula 4.

$$d_{it} = 1 - \frac{d_{i0t}}{d_{0t}} \qquad i = 1, 2, ..., n;\ j = 1, 2, ..., p;\ t = 1, 2, ..., l, \tag{4}$$

where $d_{0t} = \bar{d}_{0t} + 2s_{dt}$, and $\bar{d}_{0t}$, s_{dt} are given with formula (5).

$$\overline{d_{0t}} = \frac{1}{n}\sum_{i=1}^{n} d_{i0t}\ ,\ \ s_{dt} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (d_{i0t} - \overline{d_{0t}})^2} \qquad i = 1, 2, ..., n;\ t = 1, 2, ..., l. \tag{5}$$

The proposed method enables to group the countries into relatively homogenous sub-sets (classes) and propose rankings of the countries for the analyzed period. The rankings of the countries in the years 2001-2012 are presented in table 3a and 3b.

In the next stage the countries were grouped into five classes:

1. the countries with very high level of TMD for the QHC;
2. the countries with a high level of the measure;
3. the countries with an average level of the measure;
4. the countries with a low level of the measure;
5. the countries with a very low level of the measure.

In order to group the countries into relatively homogenous sub-sets the method of natural breaks (Jenks optimization method) was used. The main idea of the natural breaks method consists of minimization of variance for objects from the chosen subsets and maximization of variance between the subsets (Jenks, 1967, pp. 186-190). In order to catch the potential impact of the last global financial crisis, which was the additional objective of the article, the years 2001-2011 were divided into two sub-periods 2001-2007 and 2007-2011. The grouping was conducted for the years 2001, 2007 and 2011. The results of application of natural breaks method are presented in the figure 1.

Then, the dynamics of the value of TMD in the years 2001-2007, 2007-2012 and 2001-2012 was estimated. In that case also natural breaks method was applied for grouping the countries into three sub-sets that can be characterised with:

1. high dynamics of the value of TMD;
2. average dynamics of the value of the measure;
3. low dynamics of the value of the measure.

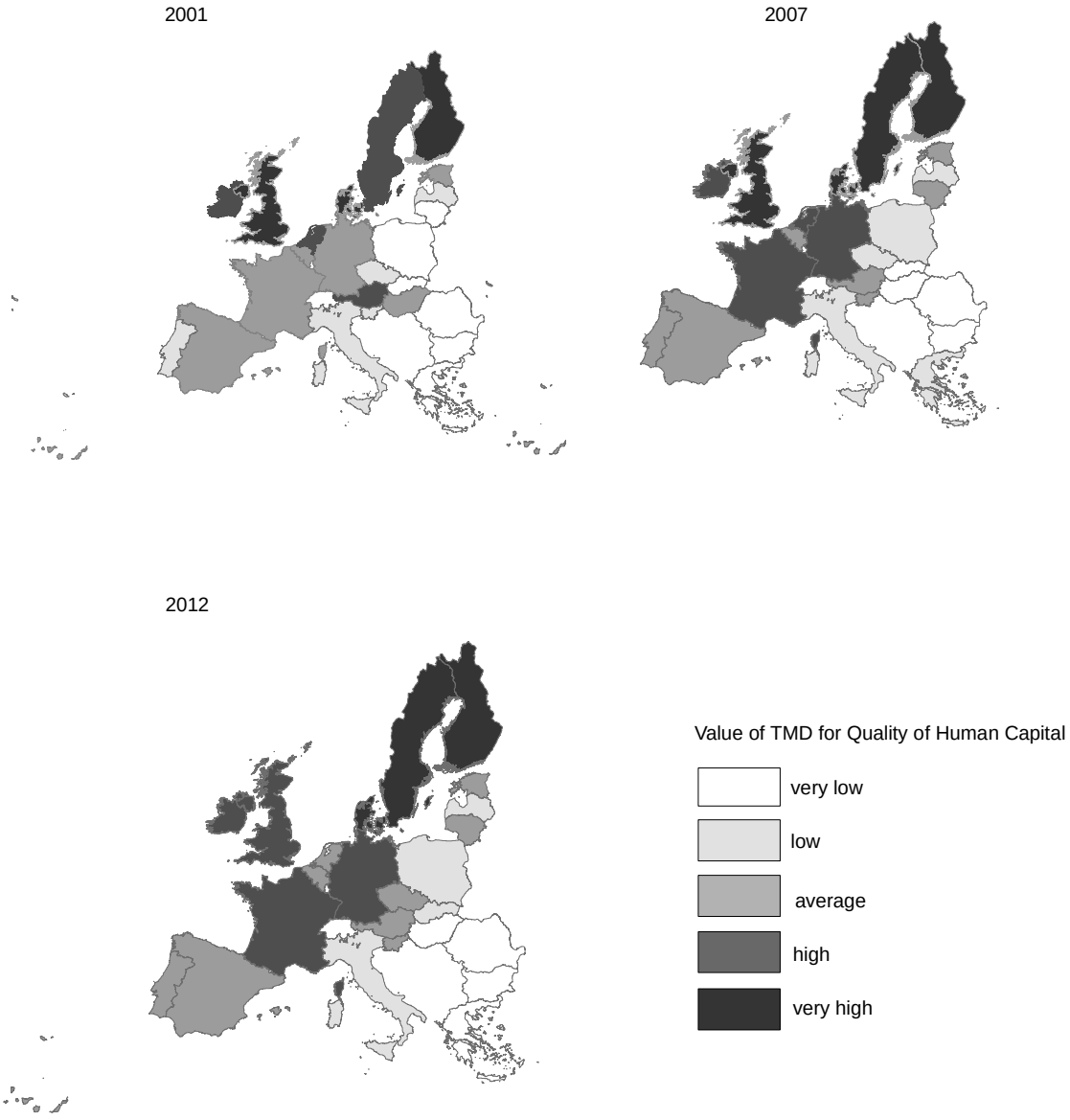
The results are presented in figure 2 and table 4.

Discussion on the Research Results

As it has been already mentioned in the methodological part of the article, the biggest weakness of every multiple-criteria analysis is a great sensitivity of final results to the differences in selection of potential diagnostic variables. Thus, the rankings and specific positions of given countries should be always treated with great caution. However, in spite of this weakness the conducted analysis can still show the structure and long term path of development of a phenomenon under evaluation. As a result, the analysis of the results of the conducted research concentrates on this perspective.

The results presented in table 3a and 3b and figure 1 show that in the last year of the research the EU countries can be generally classified to the following sub-sets: Scandinavian countries that are the leaders in terms of the QHC and should be treated as a benchmark for good practices, in the second subset one can find mainly the northern developed European economies that are characterized with relatively high level of the measure of the QHC. In this group one can find Great Britain, Ireland, France and Germany. The results of these economies are quite stable and they are the leaders in the whole period, which is quite natural when one takes into consideration their level of development and economic role in the EU.

Figure 1. Value of TMD for Quality of Human Capital in the years 2001, 2007 and 2012



Source: own estimation based on Eurostat data.

Table 3a. Results of evaluation of quality of human capital for European Union countries in the years 2001-2006

No	2001		2002		2003		2004		2005		2006	
	Country	TMD	Country	TMD	Country	TMD	Country	TMD	Country	TMD	Country	TMD
1	SE	0,7140	SE	0,7359	FI	0,7149	SE	0,7249	FI	0,7083	FI	0,7156
2	FI	0,7071	FI	0,7194	SE	0,6965	FI	0,7236	DK	0,6894	SE	0,7098
3	UK	0,6773	UK	0,6862	DK	0,6776	DK	0,6945	SE	0,6850	DK	0,6765
4	DK	0,6687	DK	0,6609	UK	0,6754	UK	0,6585	UK	0,6490	UK	0,6431
5	IE	0,4881	IE	0,4923	FR	0,5039	IE	0,4947	IE	0,5022	IE	0,4989
6	NL	0,4632	FR	0,4646	IE	0,4934	FR	0,4869	FR	0,4738	FR	0,4645
7	FR	0,4512	NL	0,4641	NL	0,4657	NL	0,4630	NL	0,4510	NL	0,4444
8	DE	0,4050	DE	0,3975	DE	0,3844	DE	0,3941	DE	0,3915	DE	0,3987
9	BE	0,3921	BE	0,3849	BE	0,3779	BE	0,3896	ES	0,3911	ES	0,3837
10	ES	0,3749	ES	0,3801	ES	0,3746	LT	0,3684	LT	0,3651	LT	0,3577
11	AT	0,3553	AT	0,3450	AT	0,3364	ES	0,3668	BE	0,3646	EE	0,3510
12	LT	0,3148	LT	0,3164	LT	0,3287	AT	0,3217	EE	0,3405	BE	0,3452
13	EE	0,3114	EE	0,3026	EE	0,3125	SI	0,3154	AT	0,3306	AT	0,3397
14	SI	0,2783	SI	0,2870	SI	0,2765	EE	0,3093	SI	0,2994	SI	0,3015
15	PT	0,2649	PT	0,2595	PT	0,2601	PT	0,2642	PT	0,2508	PT	0,2544
16	GR	0,2548	LV	0,2438	GR	0,2512	IT	0,2540	LV	0,2473	LV	0,2468
17	CZ	0,2302	GR	0,2415	LV	0,2359	LV	0,2491	IT	0,2382	IT	0,2435
18	IT	0,2284	CZ	0,2362	IT	0,2355	GR	0,2261	GR	0,2297	CZ	0,2377
19	LV	0,2237	IT	0,2338	CZ	0,2243	CZ	0,2257	CZ	0,2221	GR	0,2021
20	PL	0,1884	BG	0,1899	PL	0,1803	PL	0,1772	PL	0,1729	PL	0,1853
21	BG	0,1572	PL	0,1788	BG	0,1635	BG	0,1621	SK	0,1469	RO	0,1490
22	RO	0,1557	SK	0,1724	HU	0,1633	HU	0,1568	RO	0,1428	BG	0,1463
23	SK	0,1459	HU	0,1521	RO	0,1510	RO	0,1496	HU	0,1422	SK	0,1452
24	HU	0,1432	RO	0,1268	SK	0,1389	SK	0,1447	BG	0,1403	HU	0,1372

Source: own estimation based on Eruostat data.

Table 3a. Results of evaluation of quality of human capital for European Union countries in the years 2007-2012

No	2007		2008		2009		2010		2011		2012	
	Country	TMD	Country	TMD	Country	TMD	Country	TMD	Country	TMD	Country	TMD
1	FI	0,7332	FI	0,7445	FI	0,6905	FI	0,7380	FI	0,7051	FI	0,6916
2	DK	0,6974	SE	0,6619	DK	0,6523	DK	0,6590	DK	0,6686	DK	0,6773
3	SE	0,6745	DK	0,6553	SE	0,6396	SE	0,6410	SE	0,6571	SE	0,6553
4	UK	0,6197	UK	0,5929	UK	0,5710	UK	0,5695	UK	0,5379	UK	0,5236
5	IE	0,4870	IE	0,4670	IE	0,4373	IE	0,4558	IE	0,4483	IE	0,4462
6	FR	0,4517	NL	0,4209	DE	0,4191	DE	0,4303	DE	0,4434	FR	0,4371
7	NL	0,4363	FR	0,4200	FR	0,4177	FR	0,4197	FR	0,4252	DE	0,4309
8	DE	0,4039	DE	0,4060	NL	0,4082	NL	0,3908	EE	0,3750	NL	0,3896
9	BE	0,3796	EE	0,3569	AT	0,3502	AT	0,3636	NL	0,3728	EE	0,3720
10	ES	0,3681	ES	0,3554	EE	0,3422	ES	0,3475	ES	0,3665	SI	0,3449
11	EE	0,3674	LT	0,3401	ES	0,3421	EE	0,3369	LT	0,3382	AT	0,3426
12	LT	0,3643	AT	0,3337	LT	0,3292	SI	0,3256	AT	0,3332	LT	0,3296
13	AT	0,3362	BE	0,3230	BE	0,3116	BE	0,3215	SI	0,3332	ES	0,3277
14	PT	0,3053	PT	0,3225	PT	0,3037	LT	0,3176	PT	0,3250	PT	0,3136
15	SI	0,2915	SI	0,2737	SI	0,2822	PT	0,2941	BE	0,3138	BE	0,3106
16	LV	0,2481	CZ	0,2672	CZ	0,2566	CZ	0,2753	CZ	0,3014	CZ	0,3079
17	CZ	0,2465	LV	0,2286	LV	0,1998	LV	0,2062	PL	0,2105	LV	0,2210
18	IT	0,2310	IT	0,2063	GR	0,1842	PL	0,1946	LV	0,2056	PL	0,2192
19	PL	0,1884	GR	0,2031	IT	0,1785	SK	0,1932	SK	0,1885	SK	0,1842
20	GR	0,1838	PL	0,1761	PL	0,1712	GR	0,1867	IT	0,1750	IT	0,1756
21	RO	0,1516	RO	0,1743	RO	0,1693	IT	0,1704	GR	0,1594	GR	0,1471
22	SK	0,1499	SK	0,1609	SK	0,1661	RO	0,1419	RO	0,1323	RO	0,1175
23	BG	0,1356	BG	0,1358	BG	0,1333	BG	0,1374	BG	0,1102	BG	0,1076
24	HU	0,1098	HU	0,0801	HU	0,0763	HU	0,0840	HU	0,0741	HU	0,0827

Source: own estimation based on Eurostat data.

However, more dynamic results one can see in the case of the next three subsets grouping the countries from average to very low level of the value of the TMD for the QHC. In the last year in the sub-sets with the average and low level of obtained measure one can find Spain, Portugal, Austria, with the exception of Hungary the Central European economies that joined the EU in the year 2004 and Italy. In this group special attention should be given to relatively good results obtained by Estonia, Latvia, Czech Republic and Slovenia that in comparison with the starting point were able to improve significantly their results.

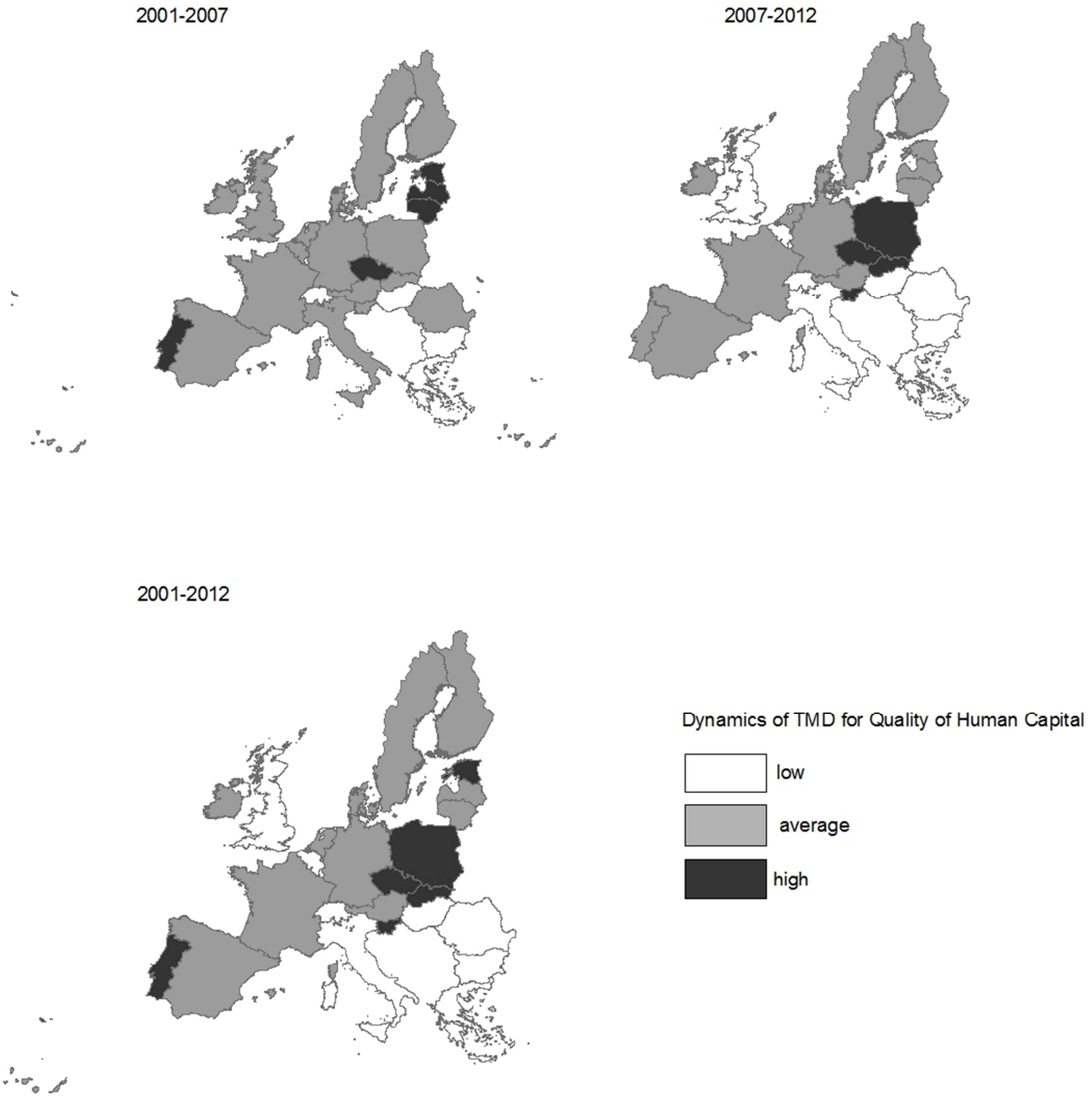
In the last group characterized with the lowest level of measure of the TMD one can find Hungary, Romania and Bulgaria and Greece. In this group the lowest position of Hungary can be considered as quite unexpected result. This low rank is mostly the consequence of relatively weak results of this country in the case of participation rate in education and training and the worst results in the number of tertiary graduates in science and technology, which in the whole period was much below the average.

Table 4. Dynamics of value of TMD for Quality of Human Capital in the years 2001-2007, 2007-2012 and 2001-2012

Country	2001-2007	Classification	Country	2007-2012	Classification	Country	2001-2012	Classification
EE	18,01%	High	CZ	24,90%	High	CZ	33,72%	High
LT	15,73%	High	SK	22,89%	High	SK	26,19%	High
PT	15,25%	High	SI	18,32%	High	SI	23,96%	High
LV	10,90%	High	PL	16,34%	High	EE	19,48%	High
CZ	7,06%	High	DE	6,67%	Average	PT	18,39%	High
SI	4,76%	Average	PT	2,73%	Average	PL	16,35%	High
DK	4,29%	Average	AT	1,93%	Average	DE	6,38%	Average
FI	3,69%	Average	EE	1,25%	Average	LT	4,71%	Average
SK	2,68%	Average	SE	-2,85%	Average	DK	1,29%	Average
IT	1,11%	Average	DK	-2,88%	Average	LV	-1,25%	Average
FR	0,11%	Average	FR	-3,24%	Average	FI	-2,20%	Average
PL	0,00%	Average	FI	-5,68%	Average	FR	-3,14%	Average
IE	-0,22%	Average	IE	-8,37%	Average	AT	-3,57%	Average
DE	-0,27%	Average	LT	-9,53%	Average	SE	-8,22%	Average
ES	-1,81%	Average	NL	-10,69%	Average	IE	-8,57%	Average
RO	-2,65%	Average	LV	-10,95%	Average	ES	-12,58%	Average
BE	-3,19%	Low	ES	-10,96%	Average	NL	-15,88%	Average
AT	-5,39%	Low	UK	-15,51%	Low	BE	-20,79%	Low
SE	-5,52%	Low	BE	-18,18%	Low	UK	-22,69%	Low
NL	-5,81%	Low	GR	-19,97%	Low	IT	-23,13%	Low
UK	-8,50%	Low	BG	-20,63%	Low	RO	-24,56%	Low
BG	-13,76%	Low	RO	-22,51%	Low	BG	-31,55%	Low
HU	-23,36%	Low	IT	-23,97%	Low	HU	-42,25%	Low
GR	-27,86%	Low	HU	-24,65%	Low	GR	-42,27%	Low

Source: own estimation based on Eurostat data.

Figure 2. Dynamics of value of TMD for Quality of Human Capital in the years 2001-2007, 2007-2012 and 2001-2012



Source: own estimation based on Eurostat data.

The dynamics of the value of the TMD, which is presented in table 4 and figure 2, shows that the biggest improvement was obtained by Portugal as the only old member country and new member states such as Baltic countries, Poland, Czech Republic, Slovakia and Slovenia. These results could be interpreted as quite natural as in the first year of the analysis the new member states generally started from relatively low level of the value of the TMD. Thus, it could be only treated as a statistical low base effect or simple result of caching up process. However, when one looks at the results of Estonia that was rated in the first year in the third group of countries with average level of the value of the TMD or the results of Slovenia and Czech Republic that were classified in the same group as Italy and Portugal, the explanations concentrating on the simple statistical effect cannot be easily accepted. Additionally, the data on the dynamics of the TMD shows that such new members as Romania, Bulgaria and Hungary were not able to improve their results. This

divergence in relation to the value of the TMD among the new member states shows that the improvements of the QHC at macroeconomic level can be strongly influenced by institutional and policy factors that should be the subject of future detailed research.

The comparison of the dynamics of the value of the TMD in the years 2001-2007 and 2007-2011 can be useful in looking for potential influence of the last global financial crisis on the changes of the QHC at macroeconomic level. The data presented in table 4 confirms that with the exception of Portugal the countries seriously affected by the crisis in the second sub-period were characterised with significantly bigger decreases of the value of the TMD than in the years 2001-2007. Greece makes the most obvious example here, but it can be also seen in the case of Italy, Spain, Ireland and Great Britain. The opposite situation can be seen in the case of the new member states that were not so much negatively affected by the crisis as the old Europe. The dynamics of their values of the TMD was generally higher in the second sub-period. These factors can confirm the influence of the global financial crisis on the relative level of the QHC form macroeconomic perspective.

Conclusions

The main objective of the article was the multiple-criteria analysis of the QHC in the EU countries at macroeconomic level. In this regard the application of taxonomic Hellwig's method of measure of development with the constant pattern enabled to conduct the dynamic analysis in the years 2001-2011 and to evaluate the relative changes of the phenomenon in that period. Additionally the obtained time series can be used in future econometric research.

In regard to the results obtained by the new member states there is a visible divergence between these economies. Baltic countries, Slovenia, Poland, Czech Republic and Slovakia were able to improve their scores significantly, whereas Hungary, Romania and Bulgaria were not able to do so. This divergence confirms that the relative changes of the QHC at the macroeconomic level cannot be simply attributed to statistical effects, the "convergence" or caching up process, but they can be a consequence of institutional or policy factors.

Lastly the analysis of dynamics of the measure for the QHC was conducted for two sub-periods for the years 2001-2007 and 2007-2011. This approach confirmed that the economies, which were strongly touched by the global financial crisis, with the exception of Portugal were also characterized with serious decreases of the value of the TMD for the QHC at macroeconomic level.

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